

What Are the Odds that Smoking Will Kill You?

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Abstract: We calculated the long-term risks of death from smoking for individuals of various ages and smoking status in terms of the excess mortality contributed by smoking, over and above the baseline mortality from the same diseases caused by factors other than smoking using standard life table procedures. Since mortality data for specific smoking categories were available only from prospective studies in the late 1950s, we scaled these to the 1982 mortality levels. We assumed, for lung cancer, that the death rates for nonsmokers have not changed and, for other smoking-related diseases, that the risks of death for smokers relative to those for nonsmokers have not changed since the 1950s. Probabilities that result from alternative assumptions were also investigated and are

presented. As many as one-third of heavy smokers age 35 will die before age 85 of diseases caused by their smoking. The probabilities of death from smoking when compared with other causes may be persuasive as public education tools. Their effective use for this purpose is affected not only by the deficiencies in the public's factual knowledge of the magnitude of the risks from smoking, but also by numerous apparent misconceptions relating to the interpretation of risk information. Risk data should be presented to the public in a manner that clarifies these misconceptions and facilitates their understanding of the overwhelming risk imposed by smoking. (*Am J Public Health* 1987; 77:425-431.)

Introduction

Since the release of the Surgeon General's report on smoking in 1965, the public's general knowledge of the health hazards of cigarettes has increased. According to recent surveys, for example, smoking is consistently cited as an important cause of cancer.^{1,2}

Yet one-third of the population still smokes, and a steady increase in both the proportion and number of smokers who are heavy smokers has occurred since 1965, whether the point that defines "heavy" is 25 or 40 cigarettes per day. Thus, although there has been an overall decline in smoking prevalence from 1965 to 1983, the population prevalence of heavier smoking has remained unchanged in men and has increased in women.

Many attempts have been made to modify the public's beliefs with regard to their susceptibility to smoking-induced diseases, the severity of the consequences of these diseases, and the benefits and barriers associated with cessation (the Health Belief Model). Yet, significant gaps in the public's understanding of the risks remain.³ The failure to achieve greater reductions in smoking even in the presence of overwhelming scientific knowledge may stem, in part, from deficiencies in the details of the information presented to the public.

Examples of survey findings illustrate three types of deficiencies. First, the public appears to understand the general notion that smoking "causes disease," but not the magnitude of the risk.⁴ In surveys done in 1975, 1979, and 1980, only 53, 60, and 47 per cent, respectively, of the population were aware that smoking is a major cause of many cases of heart attack.^{5,6} These data suggest no increase in the public's understanding of the magnitude of the risk over time. In 1980, only 57 per cent of the population knew that smoking causes most cases of lung cancer and is a major cause of mouth, esophageal, and laryngeal cancer. In the same year, only 45 per cent knew that smoking causes many cases of bronchitis and emphysema, while a mere 18 per cent knew that it causes most cases of these respiratory diseases.^{5,6}

Second, it appears that the public does not understand the likelihood (i.e., the probability) of an individual's developing cancer if he/she is a nonsmoker, smoker, or a former smoker. Anecdotal statements suggest that segments of the public have a false sense of security from the observation that "not all smokers get cancer." Examples are frequently cited of relatives or friends who smoked heavily and for long periods who did not develop cancer. However, systematically collected data related to such perceptions are unavailable.

Third, the public apparently does not understand the risk from smoking relative to that from other factors causing death, as well as the seriousness of the diseases that smoking causes. National survey data are also lacking on this issue, although more limited data are suggestive. For example, when asked to rank the risk of dying in the United States from 30 activities and technologies, respondents judged nuclear power, motor vehicle accidents, and handguns as riskier than smoking.⁷ Data from focus groups conducted across the country suggest that the confused notion that "everything causes cancer" exists in the minds of some segments of the public.

Thus, three issues appear to be important aspects of the antismoking message that have not yet been fully conveyed to the public: 1) the magnitude of the risk from smoking; 2) the individual's probability of dying from smoking-induced diseases; and 3) the risk of dying from smoking relative to that from other causes of death.

In this paper, the principal focus is on the second of these issues. We have calculated the probability of death from smoking at various ages for both light and heavy smokers and for ex-smokers. The following sections describe the mechanics and limitations of the methodology and our view of the potential uses of these statistics in public education efforts.

Methods

The usual method of calculating the probability of dying of a specific disease is to construct a life table using the latest age-specific death rates for that disease.⁸⁻¹⁰ Age-specific death rates in 1982 for all of the smoking-related diseases of interest to us are available (unpublished data) from the National Center for Health Statistics (NCHS). However, these rates are available for the aggregate population only and not for specific smoking status categories, i.e., nonsmokers, lighter smokers, heavier smokers, and former smokers; and

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TABLE 1—Estimated Death Rates per 100,000 Male Population by Smoking Status, Selected Causes, 1982*

Age (years)/Cause of Death	Never Smoked	Former Smoker	Current <25 cigs/day	Current 25+ cigs/day	Observed Death Rate
35–44					
Lung Cancer	3.0	6.2	12.3	27.8	10.6
Coronary Heart Disease	17.3	27.8	67.2	85.4	43.8
All Smoking-Related Diseases	22.8	36.6	87.2	131.0	60.8
All Causes	195.5	219.0	324.6	426.3	272.6
45–54					
Lung Cancer	7.0	43.5	67.0	257.7	74.5
Coronary Heart Disease	54.8	118.4	308.0	447.2	201.0
All Smoking-Related Diseases	68.5	192.2	445.6	778.9	316.0
All Causes	389.6	518.2	923.4	1352.0	720.4
55–64					
Lung Cancer	10.0	186.6	239.3	531.0	212.8
Coronary Heart Disease	399.2	518.9	618.7	746.5	541.1
All Smoking-Related Diseases	473.0	807.6	1043.0	1577.2	888.9
All Causes	1219.7	1695.4	1902.7	2524.8	1736.1
65–74					
Lung Cancer	30.0	413.3	671.4	1395.2	406.0
Coronary Heart Disease	963.3	1319.7	1435.3	1656.8	1267.9
All Smoking-Related Diseases	1118.2	2157.6	2506.3	3738.9	2029.5
All Causes	2830.2	4047.2	4471.7	6028.3	3929.2
75–84					
Lung Cancer	46.0	654.0	1084.8	2354.2	515.9
Coronary Heart Disease	2515.1	2917.5	2590.6	3118.7	2744.0
All Smoking-Related Diseases	3135.8	4261.2	4594.9	7082.1	3951.4
All Causes	6864.5	8717.9	10845.9	10571.4	8391.4

*These rates represent mortality for the specified diseases caused by all factors, of which smoking is only one. See text for description of method used to calculate smoking-specific mortality rates from observed death rates for total population.

no such data are available from recent epidemiologic studies. Therefore, we used the death rates from the US Veterans' Study¹¹ carried out in the late 1950s and 1960s and scaled them to the level of the 1982 US mortality rates. To do this for coronary heart disease, for example, we forced the weighted average of the age-specific coronary heart disease death rates for nonsmokers, former smokers, lighter smokers, and heavier smokers to equal the 1982 coronary heart disease death rates for that age group. The weights used were the estimated distribution of the population among the four smoking status categories from the 1983 National Health Interview Survey (NCHS unpublished data). The formulation for this estimation procedure, which assumes that the age-specific relative risks from the Veterans' Study still applied in 1982, is given in Appendix 1.

In addition to coronary heart disease, this procedure was applied to all causes of death, as well as to all other smoking-related diseases combined (excluding coronary heart disease and lung cancer), including cancers of the buccal cavity, pharynx, esophagus, pancreas, larynx, and bladder, and chronic obstructive pulmonary disease.

It can be seen from Appendix 1 that holding the relative risks constant has the effect of allowing the rates for never-smokers to change from their levels at the time of the Veterans' Study. This did not seem to be a valid assumption for lung cancer, since there is some evidence that the rates for that disease among those who have never smoked have remained relatively constant over time.¹² Therefore, to obtain 1982 estimates for lung cancer death rates, we employed the procedures in Appendix 2 that hold the death rates for never-smokers constant and allow the relative risks to increase.

The 1982 death rates by smoking status as estimated by these two methods are given in Table 1. These are based on deaths caused by all factors, of which smoking is one. The death rate due to smoking, and the death rate due to all other factors were estimated by the following procedure. In a

specific age group, we estimated the number of deaths we would expect, for example, for the heavy smoker population, by multiplying that population by the nonsmoker death rate. We defined the difference between that number and the observed number of deaths among heavy smokers as the excess number of deaths due to smoking. We then used that excess number divided by the heavy smoker population as the death rate due to smoking in that category. The resulting estimates of the excess rates due to smoking are shown in Table 2. When this procedure was applied to lung cancer, for example, the remaining lung cancer deaths, not due to smoking, were combined with deaths from all other causes and all of these deaths were treated as competing risks in the subsequent life table calculations.

To estimate the probability of dying of a smoking-related disease, nine life tables were constructed, one for each disease category (lung cancer, coronary heart disease, and all smoking-related diseases), for each of the three smoking status categories. The probability of dying of a particular disease during an age interval was computed as follows. The estimates for the excess mortality rate due to smoking from Table 2 were applied to the population exposed to the risk of dying from that disease, yielding the number of deaths expected in that age group. The number of persons at risk in each particular age group was adjusted to take into account the effect of the risk of death from all other causes. The formulation for the computational method used is given in Appendix 3. In all cases, no attempts were made to adjust for other factors that could potentially increase the risk from cigarette smoking, such as concomitant exposure to asbestos, uranium, alcohol, etc. Likewise, additional risk from passive smoking was not considered.

Results

The variation by smoking category in the estimated probability of a 35-year-old man dying due to cigarette smoking of lung cancer, of coronary heart disease, or of all

TABLE 2—Estimated Death Rates per 100,000 Male Population for Excess Mortality due to Smoking, Selected Causes, 1982*

Age (years)/ Cause of Death	Former Smoker	Current <25 cigs/day	Current 25+ cigs/day
35–44			
Lung Cancer	3.2	9.3	24.8
Coronary Heart Disease	10.5	49.9	68.1
All Smoking-Related Diseases	13.8	64.4	108.2
45–54			
Lung Cancer	36.5	60.0	250.7
Coronary Heart Disease	63.6	253.2	392.4
All Smoking-Related Diseases	123.7	377.1	710.4
55–64			
Lung Cancer	176.6	229.3	521.0
Coronary Heart Disease	119.7	219.5	347.3
All Smoking-Related Diseases	334.6	570.0	1104.2
65–74			
Lung Cancer	383.3	641.4	1365.2
Coronary Heart Disease	356.4	472.0	693.5
All Smoking-Related Diseases	1039.4	1388.1	2620.7
75–84			
Lung Cancer	608.0	1038.8	2308.2
Coronary Heart Disease	402.4	75.5	603.6
All Smoking-Related Diseases	1125.4	1459.1	3946.3

*These rates subtract out the baseline mortality that results from factors other than smoking. Thus, the rates represent the "excess mortality" contributed by smoking alone. See text for method used to separate excess mortality due to smoking from other factors contributing to the mortality rate.

TABLE 3—Probability of a 35-year-old Male Dying Due to Cigarette Smoking of Lung Cancer, Coronary Heart Disease, or all Smoking-Related Diseases before a Specified Age, according to Smoking Status

Disease/ Smoking Status	Per Cent Dying before Age		
	65	75	85
Lung Cancer			
Former Smoker	1.9	4.4	6.5
Current Smoker <25	2.5	6.3	9.3
Current Smoker 25+	6.3	13.0	17.9
Coronary Heart Disease			
Former Smoker	1.7	4.0	5.5
Current Smoker <25	4.6	7.4	7.7
Current Smoker 25+	6.8	10.2	11.5
All Smoking-Related Diseases			
Former Smoker	4.2	10.9	14.8
Current Smoker <25	8.7	16.9	21.0
Current Smoker 25+	15.6	28.3	36.4

smoking-related diseases before age 65, before age 75, or before age 85 is shown in Table 3. Thus, a 35-year-old man who smokes 25 or more cigarettes per day has over a 6 per cent chance of dying of lung cancer *due to his smoking* before he reaches age 65, and an 18 per cent chance of doing so before age 85. The corresponding probabilities for coronary heart disease are 6.8 per cent by age 65 and 11.5 per cent by age 85. For all smoking-related diseases combined, they are 15.6 per cent by age 65, and 36.4 per cent by age 85.

The corresponding probabilities for men at ages 35, 45, 55, 65, and 75 are given in Appendix Table 1 for lung cancer, Appendix Table 2 for coronary heart disease, and Appendix Table 3 for all smoking-related diseases.

Thus far we have dealt only with that portion of the risk of death attributable to smoking. However, even those who have never smoked also have varying degrees of risk of dying

of these so-called "smoking-related diseases." For lung cancer, that risk is negligible, since most of the mortality from lung cancer can be attributed to smoking. To put this into perspective, Table 4 shows the age-specific proportions of total mortality attributable to cigarette smoking for each of the three categories of diseases. Thus, for lung cancer beginning with age 55, well over 90 per cent of the risk of death can be attributed to smoking for each smoking status category. For coronary heart disease, on the other hand, less than half of the risk of mortality in those age groups can be attributed to smoking, and among those aged 75 to 84 who were heavy smokers, more than 80 per cent of the mortality can be attributed to factors other than smoking. Nevertheless, since coronary heart disease is the leading cause of death in the United States, it exacts a heavy toll of mortality due to smoking.

For a 35-year-old man who has never smoked, the probability of dying of lung cancer before reaching age 65 is only 0.2 per cent, and 4.2 per cent for coronary heart disease. The corresponding probabilities of death due to smoking among those who smoke 25 or more cigarettes per day are 6.3 per cent and 6.8 per cent, respectively. Thus, the differential between the nonsmoker and the heavy smoker in the probability of dying before age 65 is much greater for lung cancer (30-fold increase) than it is for coronary heart disease (1.6-fold increase).

Discussion

We have quantified the chances that individuals with a specific smoking experience will die of a given disease before reaching a specified age. All the results presented here are drawn from historical data bases for males. Comparable data for female cohorts that reflect the effects of their past peak smoking prevalences are now only beginning to accumulate. However, the explosive increase in lung cancer rates for women now being seen suggests that similar smoking exposure produces similar risks in both sexes, but detailed data-based demonstrations are not yet possible.

One of the problems that resulted from our method of estimating 1982 age-specific, smoking-specific death rates for lung cancer is that the risks of death among categories of smokers relative to those among nonsmokers were permitted to find their own levels because we held the rates among nonsmokers constant. This led to high relative risks in some categories. Some investigators have argued that lung cancer death rates among nonsmokers have remained constant over the years^{12,13} while others have attempted to show that they have increased.¹⁴ If we were to hold the relative risks for the various categories of smokers constant and allow the death rates among nonsmokers to increase, the resulting probabilities of dying from lung cancer compared with those obtained when we held the nonsmoker rates constant are shown in Appendix Table 4. Review of this Table suggests that the choice between these two assumptions makes very little difference in the estimates of probabilities of dying due to smoking.

The probability estimates presented in this paper were based on estimates of death rates for 1982 projected from the mortality rates from the US Veterans' Study (carried out in the late 1950s and the early 1960s), and on the assumption that these 1982 rates will continue in the future. Because of the heavy impact of cigarette smoking on lung cancer, it might be well to examine the extent to which this assumption of constant death rates into the future for specific categories of smokers will continue to hold.

TABLE 4—Age-Specific Attributable Risks by Smoking Status, Males, 1982

Disease/ Smoking Status	Age (years)				
	35–44	45–54	55–64	65–74	75–84
Lung Cancer					
Former Smoker	.52	.84	.95	.93	.93
Current Smoker <25 cigs/day	.76	.90	.96	.96	.96
Current Smoker 25+ cigs/day	.89	.97	.98	.98	.98
Coronary Heart Disease					
Former Smoker	.38	.54	.23	.27	.14
Current Smoker <25	.74	.82	.35	.33	.03
Current Smoker 25+	.80	.88	.47	.42	.19
All Smoking-Related Diseases					
Former Smoker	.38	.64	.42	.48	.26
Current Smoker <25	.74	.85	.55	.55	.32
Current Smoker 25+	.83	.91	.70	.70	.56

An examination of the trends in lung cancer mortality rates reveals that the age-adjusted rate for White males has begun to level off in the past few years; it is actually decreasing for the age groups under 45. Between the ages of 45 and 65, these rates are beginning to level off, while for the older ages they still continue to increase but at a slower rate. These trends have not occurred for Blacks nor for White women in whom the lung cancer mortality rates have continued to increase at a rapid pace.

We believe that the probabilities presented in this paper can be useful as public information tools, and add a dimension of information not previously emphasized in educational campaigns. The concept of risk can be explained to the public in relative or absolute terms, both of which are important to an individual's understanding of the possible consequences of a risk factor.¹⁵ *Relative risk* describes the chances of dying for a person exposed to a particular risk factor compared to someone not exposed. The educational literature commonly contains statements that the smoker's risk of dying of lung cancer is 10 times greater than that of the nonsmoker. Such data can inform one of the degree of harmfulness of smoking, but says nothing of the likelihood of death from the disease actually occurring. Therefore, knowledge of the relative risks is necessary, but not sufficient information, since a high relative risk does not necessarily mean a high probability of occurrence. An individual may have a false feeling of security from risk information expressed only in relative terms and conclude that "it can't happen to me."

Absolute risk, on the other hand, tells the individual the probability that he will die of the disease, that is, it states the proportion of those exposed to the risk factor who will actually die. The probabilities of eventually dying of various cancers for the US population for the major race-sex groups have been calculated¹⁶ and have been used as part of public educational programs. For death from lung cancer, the probabilities across the four race-sex groups range from 2.9 per cent to 8.1 per cent. These figures are of value for appraising the public in a general way of changes in deaths from cancer for the overall population but are not informative for specific risk groups, i.e., smokers.

The figures for probability of death from smoking presented here are impressively large risks, especially when compared to other risks perceived as important by the public. For example, there is evidence that some people believe that they are at greater risk of dying from motor vehicle accidents than from smoking. Using the same methodology described above, we computed the probabilities of dying of motor

vehicle accidents based on the 1982 age-specific motor vehicle death rates for males aged 35 and over.¹⁷ The chance of a 35-year-old man dying of a motor vehicle accident before age 65 is 0.7 per cent and before age 85 is 1.0 per cent. Even if we considered all accidents combined, the corresponding risks are 1.5 per cent by age 65 and 2.4 per cent by age 85. This is in contrast with the risks for heavy smokers for dying of smoking: 16 per cent by age 65 and 36 per cent by age 85. Therefore, the risk of accidental death is extremely small compared with the risk of death resulting from heavy smoking. Likewise, the risk from airline crashes is frequently perceived as high by many but is actually quite trivial when one considers that in a recent year, for example, 1,468,000,000 people flew, and a total of 1,807 died, resulting in a risk of 1 in 814,000 per trip.

The challenge to public health educators in using this type of data lies not in simply presenting another set of numbers, but in using them in a context which overcomes the uninformed or illogical preconceptions that all of us, to varying degrees, use to interpret risk data. Examples of typical misunderstandings have been given by several authors.^{7,18–20} Sudden and dramatic news of causes of death appear to be more impressive, especially of recent occurrences, than are constant warnings and reminders of hazards and risks. Likewise, a cause of death that affects a large group of people collectively (such as an accident or catastrophe) is often viewed as more impressive than a cause that affects the same number of people individually. In addition, people may be more willing to accept higher risks from activities over which they have control than they would from activities over which they have little or no control. Finally, the desire for absolute certainty about a particular outcome may make even an event of relatively high probability seem less persuasive.

Perhaps, as a result of these and other types of misconceptions and preconceptions, the risks from smoking are so familiar by now that the message is becoming less newsworthy and persuasive and is losing its power. But, in fact, we have no other preventive message so powerful. We need to use the available statistics in a more creative way in order to overcome the interpretative biases that dilute the antismoking message, as long as a third of the US population continues to smoke.

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APPENDIX 1

Computation of Age-Smoking-Specific Death Rates
from Coronary Heart Disease, 1982

Let:

- p_{si} = proportion nonsmokers in age group i (from 1983 NHIS)*
 p_{fi} = proportion former smokers in age group i (from 1983 NHIS)
 p_{li} = proportion light smokers in age group i (from 1983 NHIS)
 p_{hi} = proportion heavy smokers in age group i (from 1983 NHIS)

Note: $\sum_j p_{ij} = 1$

- d_{si} = death rate among nonsmokers in age group i (from US Veterans' Study)
 d_{fi} = death rate among former smokers in age group i (from US Veterans' Study)
 d_{li} = death rate among light smokers in age group i (from US Veterans' Study)
 d_{hi} = death rate among heavy smokers in age group i (from US Veterans' Study)
 R_{fi} = risk of death among former smokers relative to that among nonsmokers in age group i
 R_{li} = risk of death among light smokers relative to that among nonsmokers in age group i
 R_{hi} = risk of death among heavy smokers relative to that among nonsmokers in age group i
 m_i = observed death rate in age group i (in 1982)

Then:

$$m_i = p_{si} d_{si} + p_{fi} R_{fi} d_{si} + p_{li} R_{li} d_{si} + p_{hi} R_{hi} d_{si}$$

Solve for d_{si} :

$$d_{si} = \frac{m_i}{p_{si} + p_{fi} R_{fi} + p_{li} R_{li} + p_{hi} R_{hi}}$$

Then:

$$\begin{aligned}
 d_{fi} &= R_{fi} d_{si} \\
 d_{li} &= R_{li} d_{si} \\
 d_{hi} &= R_{hi} d_{si}
 \end{aligned}$$

*NHIS = National Health Interview Survey

APPENDIX 2

Computation of Age-Smoking-Specific Death Rates from Lung Cancer, 1982

- p_{si} = proportion of nonsmokers in age group i
 p_{fi} = proportion of former smokers in age group i
 p_{li} = proportion of light smokers in age group i
 p_{hi} = proportion of heavy smokers in age group i
 N_i = total U.S. male population in 1982 in age group i
 N_{si} = $N_i p_{si}$ = number of nonsmokers in US male population, 1982
 N_{fi} = $N_i p_{fi}$ = number of former smokers in US male population, 1982
 N_{li} = $N_i p_{li}$ = number of light smokers in US male population, 1982
 N_{hi} = $N_i p_{hi}$ = number of heavy smokers in US male population, 1982
 D_i = number of lung cancer deaths among US males in age group i, 1982
 D_{si} = $N_{si} r_{si}$ = number of lung cancer deaths among male nonsmokers, 1982,
 where r_{si} = lung cancer death rate among nonsmokers from US Veterans' Study
 D_{fi} = $N_{fi} r_{fi}$ = preliminary estimate of lung cancer deaths among former smokers
 D_{li} = $N_{li} r_{li}$ = preliminary estimate of lung cancer deaths among light smokers
 D_{hi} = $N_{hi} r_{hi}$ = preliminary estimate of lung cancer deaths among heavy smokers
 where r_{fi} = lung cancer death rate among former smokers from US Veterans' Study
 r_{li} = lung cancer death rate among light smokers from US Veterans' Study
 r_{hi} = lung cancer death rate among heavy smokers from US Veterans' Study

$$D'_{fi} = [D_i - D_{si}] \frac{D_{fi}}{D_{fi} + D_{li} + D_{hi}} = \text{number of lung cancer deaths among former smokers, 1982 (adjusted)}$$

$$D'_{li} = [D_i + D_{si}] \frac{D_{li}}{D_{fi} + D_{li} + D_{hi}} = \text{number of lung cancer deaths among light smokers, 1982 (adjusted)}$$

$$D'_{hi} = [D_i + D_{si}] \frac{D_{hi}}{D_{fi} + D_{li} + D_{hi}} = \text{number of lung cancer deaths among heavy smokers, 1982 (adjusted)}$$

- d_{si} = D_{si}/N_{si} = lung cancer death rate among nonsmokers, 1982
 d_{fi} = D'_{fi}/N_{fi} = lung cancer death rate among former smokers, 1982
 d_{li} = D'_{li}/N_{li} = lung cancer death rate among light smokers, 1982
 d_{hi} = D'_{hi}/N_{hi} = lung cancer death rate among heavy smokers, 1982

APPENDIX 3

The following are the steps taken to calculate the probability of dying from a smoking-related disease, using lung cancer among former smokers as an example.

1. From Appendix Table 1, for former smokers, calculate the age-specific death rates for all causes other than lung cancer by subtracting the rate for lung cancer from the rate for all causes within each age group
2. Convert the lung cancer and the "all other causes of death" rates to probabilities of death using the formula:

$$q_x = \frac{2nm_x}{2 + nm_x}$$

where q_x = probability of dying during the interval

m_x = death rate in the age interval

n = length of the interval—i.e., 10 years

3. Compute the number exposed to the risk of dying of lung cancer during the interval as:

$$l'_x = l_x (1 - 1/2 q_{xA})$$

where l_x = the number of survivors at beginning of interval

q_{xA} = probability among former smokers of dying during the interval of all causes other than lung cancer

4. Then the expected number of deaths from lung cancer among former smokers during this interval is:

$$D_{xL} = q_{xL} l'_x$$

where q_{xL} = probability of death from lung cancer

5. Compute $l_{x+n} = l_x - D_{xL} - D_{xA}$

where $D_{xA} = q_{xA} l'_x$ = deaths from all other causes

6. Compute the probability of a 35-year-old former smoker dying of lung cancer before age 85 as the sum of the D_{xL} for the age groups 35–44 through 75–84, divided by l_{35} , the number alive at age 35. Compute the probability of a 45-year-old former smoker dying of lung cancer before age 75 as the sum of the D_{xL} for the age groups 45–54, 55–64, and 65–74 divided by l_{45} . Compute the remaining probabilities in a similar manner.

APPENDIX TABLE 1—Excess Risk of Death among Males due to Smoking: Per Cent Probability of Dying of Lung Cancer due to Smoking

From Age	Smoking Category	Before Age		
		65	75	85
35	Former Smoker	1.9	4.4	6.5
	Current Smoker <25 cigs/day	2.5	6.3	9.3
	Current Smoker 25+ cigs/day	6.3	13.0	17.9
45	Former Smoker	1.9	4.4	6.7
	Current Smoker <25	2.5	6.4	9.5
	Current Smoker 25+	6.4	13.3	18.5
55	Former Smoker	1.6	4.3	6.6
	Current Smoker <25	2.1	6.4	9.8
	Current Smoker 25+	4.6	12.6	18.5
65	Former Smoker		3.2	5.9
	Current Smoker <25		5.2	9.4
	Current Smoker 25+		10.4	18.0
75	Former Smoker			4.2
	Current Smoker <25			6.6
	Current Smoker 25+			14.6

APPENDIX TABLE 2—Excess Risk of Death among Males due to Smoking: Per Cent Probability of Dying of Coronary Heart Disease due to Smoking

From Age	Smoking Category	Before Age		
		65	75	85
35	Former Smoker	1.7	4.0	5.5
	Current Smoker <25 cigs/day	4.6	7.4	7.6
	Current Smoker 25+ cigs/day	6.8	10.2	11.5
45	Former Smoker	1.7	4.0	5.5
	Current Smoker <25	4.2	7.1	7.4
	Current Smoker 25+	6.4	9.9	11.3
55	Former Smoker	1.1	3.6	5.1
	Current Smoker <25	2.0	5.2	5.4
	Current Smoker 25+	3.1	7.2	8.8
65	Former Smoker		3.0	4.8
	Current Smoker <25		3.8	4.1
	Current Smoker 25+		5.3	7.3
75	Former Smoker			2.8
	Current Smoker <25			0.5
	Current Smoker 25+			3.9

APPENDIX TABLE 3—Excess Risk of Death among Males due to Smoking: Per Cent Probability of Dying of All Smoking-Related Diseases due to Smoking

From Age	Smoking Category	Before Age		
		65	75	85
35	Former Smoker	4.2	10.9	14.8
	Current Smoker <25 cigs/day	8.7	16.9	21.0
	Current Smoker 25+ cigs/day	15.6	28.3	36.4
45	Former Smoker	4.1	11.0	15.0
	Current Smoker <25	8.3	16.8	21.1
	Current Smoker 25+	15.2	28.4	36.9
55	Former Smoker	3.1	10.3	14.6
	Current Smoker <25	5.2	14.5	19.2
	Current Smoker 25+	9.8	25.0	34.7
65	Former Smoker		8.6	13.6
	Current Smoker <25		11.2	17.0
	Current Smoker 25+		19.8	32.4
75	Former Smoker			7.7
	Current Smoker <25			9.3
	Current Smoker 25+			24.8

APPENDIX TABLE 4—Excess Risk of Death among Males due to Smoking: Per Cent Probability of Dying of Lung Cancer due to Smoking; Comparison of the Effect of Two Alternative Assumptions

From Age	Smoking Category	Before Age					
		65		75		85	
		Nonsmoker Rates		Nonsmoker Rates		Nonsmoker Rates	
		Constant	Not Constant	Constant	Not Constant	Constant	Not Constant
35	Former Smoker	1.9	1.7	4.4	3.6	6.5	5.3
	Current Smoker <25 cigs/day	2.5	2.2	6.3	5.4	9.3	7.9
	Current Smoker 25+ cigs/day	6.3	6.0	13.0	11.9	17.9	16.2
45	Former Smoker	1.9	1.7	4.4	3.7	6.7	5.4
	Current Smoker <25	2.5	2.2	6.4	5.5	9.5	8.1
	Current Smoker 25+	6.4	6.1	13.3	12.2	18.5	16.8
55	Former Smoker	1.6	1.6	4.3	3.7	6.6	5.5
	Current Smoker <25	2.1	2.0	6.4	5.7	9.8	8.5
	Current Smoker 25+	4.6	4.7	12.6	11.7	18.5	16.9
65	Former Smoker			3.2	2.5	5.9	4.6
	Current Smoker <25			5.2	4.4	9.4	7.8
	Current Smoker 25+			10.4	9.2	18.0	15.9
75	Former Smoker					4.2	3.2
	Current Smoker <25					6.6	5.5
	Current Smoker 25+					14.6	12.9

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